In re TURNER ET AL., Application No. 09/705,450
Amendment A

Amendments to the Claims:

The listing of clams will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1 (canceled)

Claim 2 (currently amended): An input line card comprising the apparatus of ~~claim 1~~ claim 1.

Claim 3 (currently amended): The apparatus of ~~claim 1~~ claim 7, wherein the one or more state data structures maintains an indication of one of at least three different states for each of the plurality of outputs of the packet switching system.

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Claim 4 (currently amended): ~~The apparatus of claim 3,~~ An apparatus comprising:

a plurality of rate monitors to measure the rate at which traffic arrives for each of a plurality of outputs of a packet switching system;

one or more state data structures indicating a state of each of the plurality of outputs of the packet switching system; and

a rate-controlled virtual output queue for each of the plurality of outputs of the packet switching system, each of the rate controlled virtual output queues adjusting a rate at which packets are sent to a particular destination based at least in part on a measured traffic arrival rate and a state for the particular destination;

wherein the one or more state data structures maintains an indication of one of at least three different states for each of the plurality of outputs of the packet switching system; and

wherein packets are not sent to a particular output when the particular output is in a first state, packets are sent to the particular output at approximately the measured traffic arrival rate when the particular output is in a second state, and packets are sent to the particular output at a reduced rate approximately proportional to the measured traffic arrival rate when the particular output is in a third state.

Claim 8 (currently amended): The apparatus of ~~claim 1~~ claim 4, wherein each of the rate-controlled virtual output queues includes a transmit list.

Claim 6 (currently amended): The apparatus of ~~claim 1~~ claim 4, wherein each rate-controlled virtual output queue includes a timing mechanism.

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Claim ~~7~~ 6 (currently amended): ~~The apparatus of claim 6,~~ An apparatus comprising:

a plurality of rate monitors to measure the rate at which traffic arrives for each of a plurality of outputs of a packet switching system;

one or more state data structures indicating a state of each of the plurality of outputs of the packet switching system; and

a rate-controlled virtual output queue for each of the plurality of outputs of the packet switching system, each of the rate controlled virtual output queues adjusting a rate at which packets are sent to a particular destination based at least in part on a measured traffic arrival rate and a state for the particular destination;

wherein each rate-controlled virtual output queue includes a timing mechanism; and

wherein the timing mechanism includes one or more timing wheels.

Claim ~~8~~ 7 (currently amended): ~~The apparatus of claim 6,~~ An apparatus comprising:

a plurality of rate monitors to measure the rate at which traffic arrives for each of a plurality of outputs of a packet switching system;

one or more state data structures indicating a state of each of the plurality of outputs of the packet switching system; and

a rate-controlled virtual output queue for each of the plurality of outputs of the packet switching system, each of the rate controlled virtual output queues adjusting a rate at which packets are sent to a particular destination based at least in part on a measured traffic arrival rate and a state for the particular destination;

wherein each rate-controlled virtual output queue includes a timing mechanism; and

wherein the rate-controlled virtual output queue comprises at least one scheduling data structure, said at least one scheduling data structure including scheduling information with a timing granularity greater than that of the timing mechanism.

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Claim ~~9~~ 8 (original): The apparatus of claim ~~8~~ 7, wherein said scheduling information includes a target time for sending a next packet.

Claim ~~10~~ 9 (currently amended): The apparatus of ~~claim 1~~ claim 1, wherein each of the plurality of rate monitors include one or more data structures maintaining an indication of a packet count and a reference time period.

Claim ~~11~~ 10 (original): A method performed by a packet switching system, the method comprising:

receiving packets at a first component of the packet switching system, at least a subset of the received packets being destined for a second component of the packet switching system;

maintaining a state data structure indicating a state of the second component;

maintaining a rate data structure reflective of an arrival rate at which packets destined for the second component are received at the first component;

sending received packets to the second component at a first rate approximately proportional to the arrival rate when the state data structure indicates the second component is in a first state; and

sending received packets to the second component at a second rate less than the first rate and greater than zero, and approximately proportional to the arrival rate when the state data structure indicates the second component is in a second state.

Claim ~~12~~ 11 (original): The method of claim ~~11~~ 10, wherein the first rate is approximately the arrival rate of the received packets.

Claim ~~13~~ 12 (original): The method of claim ~~11~~ 10, wherein the rate data structure includes a count of a subset of the received packets.

Claim ~~14~~ 13 (currently amended): The method of claim ~~11~~ 10, wherein ~~the~~ a set of possible states for the state of the second component ~~include~~ includes an unconstrained state, an off state, and a backlogged ~~states~~ state.

Claim ~~15~~ 14 (original): The method of claim ~~14~~ 13, further comprising sending no received packets to the second component from the first component when the state data structure indicates the second component is in an off state.

Claim ~~16~~ 15 (original): A method performed by a packet switching system, the method comprising:

receiving a plurality of packets, each of the received plurality of packets being destined for one or more of a plurality of outputs of the packet switching system;

measuring a traffic arrival rate for each one of the plurality of outputs of the packet switching system, the traffic arrival rate reflective of the rate at which traffic arrives for a corresponding one of the plurality of outputs of the packet switching system;

maintaining an indication of a state of said each one of the plurality of outputs of the packet switching system;

sending received packets to a particular one of the plurality of outputs at a first rate approximately proportional to the measured traffic arrival rate for the particular one of the plurality of outputs when the maintained state indication reflects the particular one of the plurality of outputs is in a first state; and

sending received packets to the particular one of the plurality of outputs at a second rate less than the first rate and greater than zero, and approximately proportional to the measured traffic arrival rate for the particular one of the plurality of outputs when the maintained state indication reflects the particular one of the plurality of outputs is in a second state.

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Claim ~~17~~ 16 (original): The method of claim ~~16~~ 15, wherein no packets are sent to a particular one of the plurality of outputs when the maintained state indication reflects the particular one of the plurality of outputs is in a third state

Claim ~~18~~ 17 (currently amended): The method of claim ~~16~~ 15, ~~where the state data structure is~~ wherein said indications of said states of the plurality of outputs are updated based on received flow control information.

Claim ~~19~~ 18 (original): The method of claim ~~16~~ 15, wherein said method is performed by an input line card of the packet switching system.

Claim ~~20~~ 19 (original): The method of claim ~~16~~ 15, wherein measuring the traffic arrival rate includes maintaining a packet count and a time reference.

Claim ~~21~~ 20 (original): The method of claim ~~16~~ 15, further comprising:

maintaining a packet queue for each output of the packet switching system; and

placing each packet of the plurality of received packets in one of the plurality of packet queues based on a destination of said each packet.

Claim ~~22~~ 21 (original): The method of claim ~~21~~ 20, further comprising placing an indicator of a corresponding one of the plurality of packet queues in a transmit list upon arrival of a particular received packet having a destination of a selected one of the plurality of outputs being in the first state.

Claim ~~23~~ 22 (original): The method of claim ~~16~~ 15, wherein sending received packets to the particular one of the plurality of outputs at the second rate includes:

sending one of the plurality of packets to the particular one of the plurality of outputs of the packet switching system; and

rescheduling the particular one of the plurality of outputs of the packet switching system in a timing data structure for a second scheduled time based upon the measured traffic arrival rate for the selected output.

Claim ~~24~~ 23 (original): The method of claim ~~23~~ 22, wherein sending received packets to the particular one of the plurality of outputs at the second rate includes retrieving a transmit indication corresponding to the particular one of the plurality of outputs of the packet switching system from the timing data structure at a first scheduled time.

Claim ~~25~~ 24 (original): The method of claim ~~25~~ 22, wherein the second scheduled time reflects an actual time to send one of the plurality of packets to the selected output of the packet switching system rather than a time relative to a last sent packet to the selected output of the packet switching system.

Claim ~~26~~ 25 (original): The method of claim ~~23~~ 22, wherein the timing data structure includes one or more timing wheels.

Claim ~~27~~ 26 (original): The method of claim ~~23~~ 22, comprising maintaining a target time for the sending one of the plurality of packets, wherein the second scheduled time is approximately the target time.

Claim ~~28~~ 27 (original): The method of claim ~~27~~ 26, wherein the target time has a finer timing resolution than that of the timing data structure.

Claim ~~29~~ 28 (currently amended): The method of claim ~~16~~ 15, wherein sending received packets to the particular one of the plurality of outputs at the second rate includes:

retrieving a transmit indication corresponding to a selected output of the plurality of outputs of the packet switching system from a timing data structure at a first scheduled time and ~~placing the~~ placing the retrieved transmit indication in a transmit list;

removing the retrieved transmit indication from the transmit list and sending one of the plurality of packets to the corresponding selected output of the plurality of outputs of the packet switching system based on the retrieved transmit indication; and

rescheduling the sending one of the plurality of packets to the corresponding selected output of the plurality of outputs of the packet switching system in the timing data structure for a second scheduled time based upon the measured traffic arrival rate for the selected output.

Claim ~~30~~ 29 (original): The method of claim ~~29~~ 28, wherein the rescheduling process occurs after the transmit indication is removed from the transmit list.

Claim ~~31~~ 30 (original): The method of claim ~~29~~ 28, wherein the second scheduled time reflects an actual time to send one of the plurality of packets to the selected output of the packet switching system rather than a time relative to a last sent packet to the selected output of the packet switching system.

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Claim ~~31~~ 31 (original): A packet switch system, comprising:

means for receiving packets at a first component of the packet switching system, at least a subset of the received packets being destined for a second component of the packet switching system;

means for maintaining a state data structure indicating a state of the second component;

means for maintaining a rate data structure reflective of an arrival rate at which packets destined for the second component are received at the first component;

means for sending received packets to the second component at a first rate approximately proportional to the arrival rate when the state data structure indicates the second component is in a first state; and

means for sending received packets to the second component at a second rate less than the first rate and greater than zero, and approximately proportional to the arrival rate when the state data structure indicates the second component is in a second state.

Claim ~~32~~ 32 (original): The packet switch system of claim ~~31~~ 31, wherein the first rate is approximately the arrival rate of the received packets.

Claim ~~33~~ 33 (original): The packet switch system of claim ~~31~~ 31, wherein the rate data structure includes a count of a subset of the received packets.

Claim ~~34~~ 34 (currently amended): The packet switch system of claim ~~31~~ 31, wherein ~~the~~ a set of possible states for the state of the second component ~~include~~ includes an unconstrained state, an off state, and a backlogged ~~states~~ state.

Claim ~~35~~ 35 (original): The packet switch system of claim ~~34~~ 34, further comprising means for sending no received packets to the second component from the first component when the state data structure indicates the second component is in an off state.

36
Claim ~~37~~ (original): A machine-readable medium having stored thereon data representing sequences of instructions, said sequences of instructions which, when executed by a processor, cause said processor to perform the following:

receiving packets at a first component of the packet switching system, at least a subset of the received packets being destined for a second component of the packet switching system;

maintaining a state data structure indicating a state of the second component;

maintaining a rate data structure reflective of an arrival rate at which packets destined for the second component are received at the first component;

sending received packets to the second component at a first rate approximately proportional to the arrival rate when the state data structure indicates the second component is in a first state; and

sending received packets to the second component at a second rate less than the first rate and greater than zero, and approximately proportional to the arrival rate when the state data structure indicates the second component is in a second state.

37 36
Claim ~~38~~ (currently amended): The machine readable medium of claim ~~37~~, wherein ~~the~~ a set of possible states for the state of the second component ~~include~~ includes an unconstrained state, an off state, and a backlogged ~~states~~ state.

38 37
Claim ~~39~~ (original): The machine readable medium of claim ~~38~~, wherein said processor further performs sending no received packets to the second component from the first component when the state data structure indicates the second component is in an off state.